THE DEVELOPMENT OF PREDICTIVE GRADE POINT AVERAGE MODELS FOR COMMUNITY COLLEGE DENTAL HYGIENE AND NURSING PROGRAMS AND THE APPLICATION OF THESE MODELS IN A COMPUTERIZED ADMISSIONS SYSTEM

By

KENNETH CHARLES KOCHEY

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By

Kenneth Charles Kochey

August, 1972

Chairman: James L. Wattenbarger
Co-Chairman: John M. Nickens
Major Department: Educational Administration

This study was planned to investigate how well presently available academic and selected biographical data which were routinely obtained for each applicant can be used to predict first semester grade point averages for dental hygiene and nursing program enrollees. Twelve predictor variables and one criterion variable were studied for a sample consisting of 50 students enrolled in the dental hygiene curriculum and 94 students enrolled in the nursing curriculum at a community college. A correlation matrix was developed for each program in order to show the relationship of the individual predictors with each other as well as with the criterion variable. In addition, a multiple regression analysis was performed for the purpose of determining the prediction models.

The investigation of the relationship between the predictor variables and the criterion variable of first semester grade point average resulted in the development of a prediction model for each program which can be used by admissions personnel as an aid in the evaluation of credentials of applicants to dental hygiene and nursing programs. The dental hygiene model contained age and the high school mathematics grade point average as predictors, while the predictor variables utilized in the nursing model were age and high school percentile rank. The intellectual variables of high school mathematics grade point average and high school percentile rank were the best single predictors of first semester grade point averages for the dental hygiene and nursing programs, respectfully. It was also found that the American College Testing Program scores did not relate significantly to the criterion variable for either of the two curricula studied.

Since the multiple regression equations have acceptable multiple correlations, it is suggested that these prediction models be utilized by admissions personnel as an aid in the selection and counseling of applicants who may be admitted to community college dental hygiene and nursing programs. The models should also be useful in the counseling of students who have been refused admission to these curricula. It should be understood, however, although the models can serve as screening devices, they should not be

utilized as the only basis for the determination of the acceptability of individual candidates for admission to either the dental hygiene or nursing curricula.

CHAPTER 1

INTRODUCTION TO THE STUDY

Introduction

One of the major developments in the field of American higher education in the 1960s has been the rapid growth of the community college movement. Projections indicate that enrollments will continue to grow with at least a doubling of the student population by 1980 (14). One of the problems caused by this burgeoning student population is the necessity on the part of community college personnel to restrict enrollment in some technical curricula due to the limitations of physical, economic, and human resources. Admissions officers are faced with the increasingly difficult task of selecting and rejecting applicants for admission to technical programs which are open to limited numbers of students. Thus, admissions personnel are continually seeking assistance in making the decisions relative to which applicants should be admitted into these programs and which ones should be refused admission.

The problem of selecting applicants to certain college curricula is compounded by current attitudes of state legislators and other state officials who are questioning the increased costs of higher education. Public institutions of higher education in many states are now required to develop a Program Planning Budget System (PPBS) and, each year, submit a program planning budget with projections for the five succeeding years (24). One concern of a PPBS is the relationship of the total number of graduates, or output, of each program to the number of students who began the program. As college personnel consider the problem of how to increase each college's output, keeping in mind the limitations of enrollment, the necessity of placing students in programs commensurate with their preparation and abilities becomes more and more important.

Another area of concern to admissions officers is the efficient utilization of limited resources in their own offices. As enrollments increase, it is not always possible to maintain proportional increases in the admissions staff. Therefore, admissions personnel must constantly search for better ways to utilize the existing admissions staff in order that the needs of the individual student be adequately met. One method of increasing efficiency would be to categorize students into groups based upon their need for the admissions staff's special attention. Students who do not appear to need such attention would be processed routinely, while those who appear to need additional guidance and counseling could have this opportunity afforded to them.

Admissions personnel have access to a rich supply of student data including test scores and high school academic records. These data, if utilized effectively, can provide valuable assistance to the admissions staff in the determination of which applicants should be admitted to specific curricula. However, one of the problems of the admissions staff, especially in programs with limited enrollments, is to identify which of the data elements singularly, or in combination, are useful in selecting applicants who appear to have a reasonable chance of academic success. The conclusions reported in studies by Jenkins (30), Peerson (54), and Redford (56) indicate the need for the identification of variables which may be useful as predictors of success in college.

The fundamental reasons for conducting this study were (1) to isolate those data elements which may be the best predictors of college achievement in specific technical programs; (2) to determine the empirical relationship between these data; and (3) to develop models which could be used to facilitate the admissions decision-making process.

The Problem

Statement of the Problem

This study concentrated upon the establishment of admissions selection models for a community college's dental hygiene and nursing programs for the purpose of utilizing the models in the admissions portion of a management information system. Specifically, this study was concerned with

1. Determining the usefulness of selected data

elements in the admission of applicants to dental hygiene and nursing programs at a community college.

2. Relating the data, in the form of mathematical models, to the decision-making aspects of the admissions office of the community college.
3. The integration of these models into a computerized admissions system.

Delimitations

The delimitations of this study were as follows:

1. The sample of this study consisted of students enrolled in the dental hygiene and nursing programs at Northampton County Area Community College from the fall, 1969, through the fall, 1971.
2. This investigation utilized data which were available in the files of the Northampton County Area Community College Admissions and Registrar's Offices.
3. This investigation included the following variables:
    - High school percentile rank;
    - American College Test scores--English, mathematics, social science, natural science, and composite;
    - High school subject grade point averages--English, mathematics, social science, and natural science;
    - Age; previous dental hygiene or nursing related experience; and
    - First semester college grade point average.

Limitations

It is recognized that there are variables, other than those investigated, which might have an influence on the prediction of grade point averages. Because the emphasis in this study was confined to the use of conventional admission data which are available in the admissions system, motivation and other areas of the affective domain were not included in the development of the model.

This study was limited to the use of records obtained from a sample of students enrolled in the dental hygiene and nursing programs at Northampton County Area Community College. Therefore, the resultant prediction models should only be considered for that college. If the models are utilized by other colleges, the equations should be validated using data from that institution.

The models should be considered as tools to be used by admissions personnel for the purpose of identifying applicants who need additional counseling services. Although the models can serve as screening devices, they should not be utilized as the only basis for the determination of the acceptability of individual candidates for admission to either the dental hygiene or nursing curricula.

Definition of Terms

For the purposes of this study, the following definitions were used:

Age--The age, in years, of the student at the time of entrance into the program being studied.

College grade point average--The average as determined by dividing the total honor points by the total credit hours attempted.

High school percentile rank--The percentile (P) determined by the following formula: $P = 100\ (1 - \frac{R}{T})$ where R = rank in twelfth grade class and T = total number of twelfth grade students.

High school subject grade point average--The average determined by dividing the honor points earned in a specific high school subject such as English, mathematics, social science, and natural science, by the number of units attempted in that subject.

High school unit--This term is used to indicate the equivalent of one year of high school study in a subject-matter area.

Honor points--Honor points are determined by equating each credit hour as follows: A = 4, B = 3, C = 2, D = 1, and F = 0.

Model--The model will be represented by a regression equation in which the independent variables, in weighted combination, will predict a first semester grade point average for each applicant for admission to the dental hygiene or nursing program at a community college.

Previous experience in dental hygiene--Previous high school and/or college study in dental-related fields, or employment as a dental assistant for a period of six months or more.

Previous experience in nursing--Previous high school and/or college study in nursing-related fields, or employment as a nurse's aide in a hospital.

Success--The measure of success will be defined by the first semester college grade point average.

Justification of the Study

It is generally agreed that admissions officers are faced with selection problems for those programs having limited enrollments. The large number of applicants for matriculation into the allied health fields is one example of the problem being faced by college personnel. Therefore, a study such as this should provide community college admissions officers with information which may be utilized in the development and implementation of prediction models for two areas in the allied health fields, dental hygiene and nursing. In order to determine the prediction models, it was first necessary to determine which data elements have significant value and should be considered when selecting students for these programs. These data were then related empirically to the decision-making phase of the admissions office through the development of models for use in assessing the qualifications of applicants for community college dental hygiene and nursing programs. Implications drawn from this study may assist other community colleges which are facing similar problems. The development of objective admissions criteria also may then hopefully alleviate some of the criticism and dissatisfaction in this segment of a college's operation.

Thus one of the outcomes of this study was the development of grade point prediction models for the dental hygiene and nursing programs in a community college. The results of this study can provide students, parents, counselors, and faculty members with information which could assist them in making wiser decisions with respect to entrance into the programs. The necessity of the limitation of enrollment in the dental hygiene and nursing programs due to economic, physical, and human factors provides the impetus for the development of admissions criteria which help to select applicants with a reasonable probability of success in these programs as well as to increase the output of community college curricula.

The open-door admissions philosophy has had a major impact on the selection process of applicants to technical programs. This philosophy, which implies that the college will accept anyone who wishes to attend, does not necessarily imply that the college offers open admission to all programs (49). Jenkins (30) emphasizes this point in his study of junior college terminal and transfer curricula, when he states ". . . while junior college should continue to use the open-door admissions policy, this open door should not automatically lead to all curricula." (p. 3730) Greenwood

(25) in his study of the prediction of academic success recognized that selection procedures must be flexible. However, there must still be an effort on the part of community college personnel to admit students to selected curricula on the basis of aptitudes and abilities. McKenzie (43) stressed the responsibility of college personnel to be wary of rigid standards and to utilize cut-off scores and other requirements merely as guidelines for admission to community college curricula.

A study such as this has major importance for individual community colleges. The situation at Northampton County Area Community College provides an example of the need for this study. The admission requirements now in effect for the dental hygiene and nursing programs at Northampton County Area Community College are the same as those used in the fall, 1969. Students were admitted to these programs through the following process. According to college regulations (49), all applicants are required to submit (1) an application for admission form; (2) a high school transcript; and (3) either American College Test (ACT) scores or 15 credits of prior college study. Once these items are on file in the admissions Office, the file is evaluated by the Director of Admissions and the Director of Nursing or the Director of the Dental Hygiene Programs. Applicants who meet the minimum qualifications of an ACT English score of 17 and a "C+" average in high school English, or 15 credits of college study with a "C" average or better are then considered for acceptance on the basis of the completion date of their application (2). Qualified sponsoring school district residents are given first priority in selection to programs with limited enrollment.

The admission requirements to the dental hygiene and nursing programs at Northampton County Area Community College were developed in an attempt to assure that only qualified students were admitted to the curricula (1). However, these requirements have never been evaluated for effectiveness or reliability. The importance of such evaluation is stressed by Stone (64) in his study of the predictors of success in technical programs in which he points out the necessity for all institutions to validate their program admission requirements. Since the college has not studied the consequence of the utilization of the admissions requirements to either the dental hygiene or nursing programs, it appeared worthwhile to examine the existing criteria in order to determine the relationship between selected data elements and applicants' success in either of these programs.

In addition to this need to evaluate the dental hygiene and nursing program admission requirements, Northampton County Area Community College personnel are faced with the necessity of selecting,from a large number of applicants, those individuals who are qualified for admittance to the programs. There exists a limited number of openings in the freshman class; for example, in an admissions report issued in February, 1972, it was reported that there were 91 applicants for the 24 dental hygiene positions and 80 applicants for the 44 nursing openings in the fall, 1972, semester (16). Clearly, it is important that objective and reasonable requirements be developed so that the applicants who are admitted have the abilities required to meet success in the dental hygiene or nursing program. A study, such as this one, should provide college personnel with the data necessary to develop such requirements.

An additional purpose of this study was to utilize these models as part of the computerized admissions system. By integrating the models into this system, applicants who are likely to experience academic difficulty can be identified so that admissions personnel, counselors, and faculty members are able to provide them with special attention. Therefore, these models will provide college personnel with another tool which may be utilized in providing students with information about their chances of success in either the dental hygiene or nursing curricula. The models are also devices which may be utilized to identify those students who may experience academic difficulty. Additional attention may then be provided by the admissions staff in the form of counseling and guidance services.

In a review of the literature from 1960 to 1971, this researcher was unable to find studies which dealt with the prediction of grade point averages for dental hygiene students. Therefore, this study should serve as an important expansion of the literature in the field of dental hygiene as well as adding further information to the research concerning grade point average predictability. The results of this study could be utilized by individual colleges in the development of prediction equations or the results could serve as a benchmark for other research in the field of dental hygiene.

Thus, for the reasons mentioned in the previous paragraphs in this section, there appears to be ample justification for a study concerning the predictability of the first semester grade point average for dental hygiene and nursing applicants.

Summary

This chapter presented an introduction to the study and discussed a justification for the study. Chapter 2 consists of a review of the literature, while the procedures utilized in the study are presented in Chapter 3. Chapter 4 consists of the development of the prediction models for the dental hygiene and nursing programs. Uses of the models, conclusions, and recommendations are discussed in Chapter 5.

CHAPTER 2

REVIEW OF RELATED RESEARCH

Introduction

This chapter consists of a review of research related to the prediction of college success, the prediction of achievement in college, and the selection of students for admission to college. Of particular concern were studies which dealt with community college students.

Research Review

Study Formulation

An examination of the literature reveals the extent to which selective admissions studies have been performed. Fishman and Pasanella (18) reported that the selection of university applicants and admission to the university was one of the most intensively explored topics in educational research. However, there appears to be a paucity of literature related to selective admissions for health programs in the community college, especially in the areas of dental hygiene and nursing. Therefore, this review of research was drawn primarily from the literature concerning the college admissions process, including studies in the areas of the prediction of achievement, the prediction of academic success or failure, and the selection of students for college.

Many of these studies have involved four-year colleges and universities rather than community colleges. It should also be noted that many of these studies have been conducted within the field of the prediction of academic performance in college in general, while the prediction of academic performance in specific curricula has not been thoroughly researched.

In a review of the literature, it was apparent that there have been a number of prediction studies for entering college students. However, it appears that the bulk of these studies have been performed using as a sample four-year college and university students. Since there have been studies (33) to show that the community college student is different from his counterpart in the four-year school, it appeared that prediction studies involving community college students would serve as valuable additions to existing research.

In order to bring this research project into perspective, the majority of the literature reviewed in this section was concerned, in some way, with community colleges. Studies involving other types of institutions were utilized when it was necessary to emphasize research which was of particular relevance to this study.

In a review of the existing research, it was also evident that investigators have studied a large number of variables concerned with the predictability of success of college students. However, many of these variables require special testing to investigate personality, vocational, interest, and aptitude factors. The question arises: Can grade prediction be accomplished by utilizing student information which is readily available at the time of application to the college? If the answer to this question is in the affirmative, then savings of both time and money can be substantial. Therefore, this study was an attempt to develop prediction models based upon selected data which are readily available when the student makes application to the college.

Researchers, in attempting to define student success, have used a variety of criteria. The following studies provide support for the utilization of the student's grade point average as the criterion of success. Elias and Lindsay (13), in a study of junior college students, reported that the first term college grade point average was a useful predictor of the achievement of associate degree students. In a study of criteria measures of academic performance, Fairchild (15) reported that the total grade point average was the best measure of prediction of academic performance as opposed to the grade point average in the student's major or the grade point average in academic work in which the greatest number of semester hours were accumulated. This conclusion was also reported in a study of students who drop out of college. Stone (63) reported that the first semester grade point average had a statistically significant relationship with continuance in college.

Schroeder and Sledge (61), in an extensive review of the literature, found that intellective variables were better predictors of college achievement than nonintellective variables. Lunneborg *et al.* (41), in a prediction study concerning the prediction of academic performance, reported that aptitude and achievement measures predicted success as accurately for junior college as for four-year college students. Taylor *et al.* (65) supported the conclusions of others when, in his investigation of successful and nonsuccessful students, he found that ability factors were the best determinants of student success in collegiate programs. These factors were also more effective predictors for academically oriented curricula than for vocationally oriented programs.

High School Record as a Predictor

From a review of the literature, it was apparent that the best single predictor of college achievement was some form of the relationship to the student's high school academic record. Kern (32), in his study of freshmen at a private junior college, ". . . confirmed the consensus of predictive studies that the high school record is the best indicator of probable success in college." (p. 85) Fishman and Pasanella (18) found that high school performance, usually expressed as overall grade point average or rank in class, had the highest predictive value for forecasting university success. The literature is not clear as to which of these measures is the better predictor.

Weiss (66), in a review of the literature, reported that the most consistent and stable predictor of academic success in college is the high school rank. He also found that the reliability and stability of the high school rank was not affected by the ranking system employed, the year included in the rank, the courses used in computing the rank, or the individual variations in high school grading patterns. The conclusion that high school rank is the best predictor of collegiate achievement is also supported in other studies by Fisher (17), Leaver (35), and Quiller (55).

Kearney (31), although investigating nonintellectual factors as predictors of academic success, reported that an intellectual variable, high school grade point average, was the strongest predictor of success. McAdams (42), also supported other research when he found that high school grade point average was the best single predictor with correlations of .61 and .54 for two samples. The purpose of Larson's (34) study was to identify the student characteristics which might be employed effectively to predict the success of students enrolled in junior college business data processing programs. Although the high school grade point average was the best single predictor, Larson concluded that the open-door policy was justified for admission to business data processing programs since success did not appear to be highly contingent upon the student's achievement in high school. Long (39), in a study of four-year college students, also found that the high school grade point average is highly predictive of college grade point average, but emphasized that it is important to use other variables such as test scores to improve the predictability of success in college.

Frequently, prediction studies involve the investigation of more than one variable. Weiss (66) pointed out that the most important factor which emerged from his review of literature concerning the prediction of college success was the increased predictive effect which occurs when combining some measure of high school achievement with other predictive variables. In a study by Elias and Lindsay (13) of the role of intellective variables in the achievement of junior college students, it was reported that the intellective variables such as placement test scores and high school grade point average were useful predictors of the achievement of associate degree students.

Gwydir (27) investigated the relationship of selected variables and their interaction to student success in a community college's construction technology curriculum. He found that there was a "substantial" positive relationship between both high school mathematics average and cumulative high school average and the success of students in the program. A study by Hilton (28) of the drafting and design associate degree curricula at 13 college campuses also found that mathematics scores and high school rank were significantly correlated with college grade point average.

Lunneborg and Lunneborg (40) studied students enrolled in vocational and technical programs at 6 community colleges. They found that the grade point averages were as predictable, when using the same predictors, for students in these programs as for those students enrolled in academic areas. They also reported that high school English was the predictor studied which had the highest degree of correlation with college grade point average. Lunneborg and Lunneborg suggested that high school records should be helpful in counseling students and interpreting their chances for success or failure in specific curricula in the community college.

Researchers, in two studies, have attempted to make statistical adjustments to high school grades prior to the inclusion of these grades in the predictor equations for determining college success. Leonard (36) developed an educational index (EI) which involved a comparison of the freshman cumulative grade point average with individual high school grades. Each high school subject was assigned a weight and these weights were summed to produce an EI score. Although the EI score was the best predictor, Leonard concluded:

> In view of the small edge which EI had over high school rank in predicting cumulative grade point average, it did not seem worthwhile to expend the prodigious effort required to use the EI. High school rank was more easily obtained and performed almost as well. (p. 1937)

Morganfield (45) made adjustments in the high school grade point average in an attempt to increase the accuracy of the prediction of junior college students. He found that, because the public high schools in this sample did not have widely varying standards of grading, there was only limited success in the attempt to improve prediction of accomplishment.

Standardized Tests as Predictors

Researchers have used a variety of standardized tests as predictors of college achievement. In a paper developed by Munday (47), the predictive validity of the American College Test (ACT), Scholastic Aptitude Test (SAT), and the School and College Ability Test (SCAT) were compared. One of Munday's conclusions was that since the predictive validity varied so widely from one college to the next, it was important that each college determine its own individual validity for each test. He also noted that there are differences in predictability of curricular subgroups within each college, and therefore several different equations should be developed for predicting grades so that these differences can be taken into account.

The purpose of a study by Redford (56) was to investigate the usefulness of selected variables in predicting the grade point averages of community college freshmen. She found that the best single predictor studied for the total sample was the ACT English score, while at least one of the five ACT scores was the best predictor in 11 of the 15 subgroups of the study. Foster and Danskin (19), in a study of the utilization of the ACT, found that the ACT alone accounted for 35 to 50 percent of the variance in first semester college grades, while the ACT and high school rank together accounted for 45 to 65 percent of the variance.

In a study of the prediction of academic achievement for community college students, Gell and Bleil (23) concluded that the predictor variables of ACT scores and high school grades for female and career students had a correlation of .49 with first semester grade point averages. An investigation by Nash (48) had as its purpose the prediction of the academic achievement of women at a private junior college. He reported that a combination of the high school grade point index and ACT composite score was the best intellective predictor of success. Baird (3), in a study of junior college occupational programs, found that cumulative college grades were predictable with satisfactory accuracy using the ACT scores and high school grades. The purpose of a study by Black (6) was to study the efficiency of the utilization of high school grades and the ACT scores in predicting achievement of college students. He concluded that the ACT English score and the high school grade point average were "fairly accurate" predictors of academic achievement.

Groenke (26) investigated the relationship of ACT scores to the performance in college of adult students and recent high school graduates. He found that there was a greater relationship between the ACT battery scores and the college grade point averages for the recent high school graduate than for the adult student.

Dohner (11) investigated the relationship of some non-intellective factors, as measured by the Opinion, Attitude, and Interest Survey (OAIS), high school rank, and the ACT to the first semester grade point average of university freshmen. He found that the high school rank and ACT were good predictors of college grade point average, but that the factors measured by the OAIS did not add enough to the predictability of grades to warrant its use. In a study involving technical institute students, Libby (38) found that the ACT scores showed much greater relationship with achievement than did the high school grades, with the ACT mathematics and composite scores showing the highest correlation. Libby's multiple regression equation,using ACT scores and high school grades as predictor variables and the first semester college grade point average as the criterion variable, yielded multiple correlations ranging from .44 to .77.

Several studies report less encouraging results when using standardized test scores to predict college achievement. The relationships between high school grade point average, the American Council on Education Psychological Examination, and the Cooperative English, Biology, Chemistry, and Physics Tests on the prediction of achievement of junior college students were reported by Morice (46). He found that various combinations of the high school grade point average and standardized test scores did not provide significantly higher multiple correlations with college grades than the correlation of high school grade point average used alone.

In a study performed at a midwestern university (57), it was found that ACT scores were not indicative of which students would graduate, and that the high school percentile rank was more closely related to college success than scores obtained on the ACT examinations. The report recommended that, for the purposes of admission to the university, ACT scores should not be used as the only criterion, but should be used in conjunction with other variables. Worsley's (69) study was concerned with the prediction of achievement of junior college freshmen. He concluded that high school achievement data are better predictors than are aptitude test scores and that better predictions can be made by combining the variables than by using them separately. He also pointed out that the ACT battery should not be the sole factor in determining the placement of a student in a course or curriculum due to the low correlations in this study. He recommended that a combination of the high school average and ACT scores be utilized to predict first semester grade point average.

Hoyt (29) attempted to determine whether ACT scores and high school grades could be effective predictors of academic performance of students enrolled in community college technical-occupational curricula. He reported that the combinations of high school grades and ACT scores were valid predictors for students enrolled in the technical curricula, but warned that these predictors were not as powerful as they were for the students enrolled in the traditional academic programs.

Nonintellectual Variables as Predictors

Several studies show a relationship between age and success in college. Root (58) performed a regression analysis of 13 variables in order to predict the success of community college students. He reported that among the variables studied, the ACT composite score, high school percentile rank, and the number of years between high school and college had the highest correlation with the college grade point average. A sample of high school dropouts enrolled in a community college was studied by Russo (60) in an attempt to predict academic achievement. He reported that there existed significant relationships between college grade point averages and the ACT English, mathematics, and natural science scores. In addition, older students performed better academically than younger students. Foxworth (20) conducted a study of factors related to the academic performance of community college students, in which he found that the best predictor of success was high school grade point average; however, the number of years a student had been out of school before attending college also appeared to have some effect upon the grade point average.

Researchers have also found that the number of high school courses which a student completes may have an effect upon his college achievement. Campbell (7) reported that either of the two predictors, high school rank or high school grade point average, were equally consistent in predicting scholastic achievement. He also found that those university students who have completed four units of high school mathematics were more likely to have higher scholastic achievement than those with fewer units in these areas. Easton (12) investigated the relationships between high school courses and achievement in college courses and found that the number of high school courses related positively to the achievement of students in their first college courses. Osegard (51) conducted a study to investigate the relationship of the quantity of selected high school subjects, ACT scores, and rank in class to the success of university students. He found that high school class rank was the best single predictor of success, with the number of units of high school mathematics and science also having an effect on predictability.

The program in which a student majored in high school may have some effect on a student's success in college.

Sterrett (62) studied various aspects of college student continuation and withdrawal and concluded that students who remained in school tended to have majored in the college preparatory program in high school, while those students who withdrew from the university tended to major in agriculture, business, or technical programs in high school.

Prediction of Success in Individual Programs

The individuality of each college is such that several researchers have stressed the need for studies involving single institutions. The relationship of variables to the prediction of student success in community colleges was the purpose of a study by Peerson (54). He emphasized in one of his conclusions that individual community colleges should develop their own instruments or equations, using combinations of variables in the various curricula. An attempt was made by Curran (9) to evaluate the relationship of selected personal characteristics to the achievement of entering freshmen at seven community colleges. He concluded that instead of attempting to develop a single rule which affects all colleges, research should be devoted to the needs of each individual college student body.

One of the needs of community colleges is the study of student achievement or success in individual programs. Since the concern of this research is the study of dental hygiene and nursing programs, attention will now be drawn to the literature in these two fields. The amount of literature is sparse in these areas, with most of the existing studies produced being concerned with the nursing curriculum.

Fundak and Kreit (22) report that the aptitude tests of the Dental Hygiene Aptitude Testing Program have shown to be beneficial in predicting the academic success of students. However, the personality subtests of this program were ineffective in predicting student scholastic performance. They also found that peer ratings were significant in predicting student performance.

Levitt (37), in a review of the literature concerning the prediction of nursing student achievement, reported that:

> A number of studies have had limited success in predicting nursing student achievement via personality factors; others have been complete failures. None has yet proven pragmatically useful to schools of nursing. (p. 256)

Best (5) found that by using 24 variables consisting of intellective and biographical data, he was able to develop multiple regression equations for the prediction of success for a variety of criteria including first year grade point average and grade point averages in selected nursing courses.

Owen's (52) study of an associate degree nursing program also had as its purpose the development of multiple regression equations for use in predicting academic performance. He found that the equation which was used to predict first semester grade point averages predicted consistently lower than the observed achievement of the nursing students.

Carlson (8) studied the effect of selected predictors on the success of nursing students enrolled in a community college. It was reported that age, SCAT-Verbal test score, and high school chemistry showed low to moderate correlation with nursing grades. Carlson also noted that older students earned significantly higher state board examination scores. The need for further study of predictors was stressed. In a study of predictors of success in nurse training, Michael (44) found that the high school grade point average was significantly related to success in science and nursing courses. Wittmeyer *et al*. (67), in a study of academic performance of nursing students, investigated the ACT scores as predictive variables. They concluded that the ACT mathematics score was the only one of the ACT scores which was significant in the prediction of the grade point averages of students who completed the nursing program.

An attempt to establish relationships between admissions practices and attrition of associate degree nursing programs was one of the purposes of a study by Franklin (21). She used,as a sample, the students admitted to both selective and nonselective associate degree programs. Her analysis of the data revealed that those nursing students who were admitted under selective admissions policies did not achieve higher grade point averages, but were more successful in passing state board examinations. Franklin concluded that academic problems would follow from nonselective admissions practices, and recommended counseling and guidance for students prior to entrance and during enrollment in the nursing program.

Statistical Technique

The use of multiple regression equations is an accepted statistical technique in the prediction of student achievement. Owen *et al*. (53), in a summary of literature concerning nursing students, reported that the studies of achievement rarely utilize multiple regression equations, "Yet the latter [regression equations] seems essential if true prediction systems employing synthesis of predictor variables are to be accomplished." (p. 867) Woodward (68) investigated the efficiency of multiple regression analysis and multiple cutoff analysis in the prediction of academic performance. He found that the multiple regression analysis was clearly the most efficient process of identifying high-performing and low-performing groups. Roudabush (59) cautioned that, when using multiple regression analysis, missing data may have an appreciable effect on the prediction weights and therefore care should be exercised in the selection of the data elements for the sample.

Summary

Numerous studies have been carried out concerning predictability of college grade point averages; however, the majority of these studies have been framed within the context of four-year colleges and/or universities. The literature is conspicuously lacking in studies of community colleges and the predictability of grade point averages for students entering technical programs. Therefore the purpose of this study was to explore, in a community college setting, the relationship between the first semester college grade point average and selected variables identified by other studies as possible predictors of academic success.

CHAPTER 3

RESEARCH METHOD

Introduction

This portion of the research report will present the methods by which this investigation was performed and includes a discussion of the sample studied, the method of data collection, and the procedure by which the data were analyzed.

Procedures

Sample

The sample for this study included all students who were enrolled in the dental hygiene and nursing curricula at Northampton County Area Community College from the fall, 1969, through the fall, 1971. The total sample size was 160 students, with 56 enrolled in the dental hygiene curriculum and 104 enrolled in the nursing curriculum. Of the total sample, 6 dental hygiene and 10 nursing students withdrew during the semester, thereby reducing the sample size to a total of 144, including 50 dental hygiene and 94 nursing students.

Data Collection

The data for this study were collected from the files located in the Admissions Office and Registrar's Office at Northampton County Area Community College. Each student's record was inspected and the data recorded on coding sheets by the researcher. In cases where there were missing high school data, the researcher contacted the high school from which the student graduated to ascertain the relevant information. In cases where the student submitted tests other than the ACT, scores were interpolated into comparable ACT scores so that these individuals could be included in this study.

The data were gathered from the application material on file in the Admissions Office and consisted of the following:

Age of student in years at date of entry into freshman class;

American College Test scores--English, mathematics, social science, natural science, and composite;

High school grade point average--English, mathematics, social science, and natural science;

High school percentile rank; and

Previous dental- or nursing-related experiences.

The students' first semester grade point averages, the criterion variable, were gathered from student transcripts on file in the Registrar's Office.

A computer data card was keypunched for each student and included the following information:

1. Identification number
2. Curriculum
3. High school percentile rank

4. American College Test English Score
5. American College Test Mathematics Score
6. American College Test Social Science Score
7. American College Test Natural Science Score
8. American College Test Composite Score
9. High School English Grade Point Average
10. High School Mathematics Grade Point Average
11. High School Social Science Grade Point Average
12. High School Natural Science Grade Point Average
13. Age in years, as of August 31, in the year of entrance to the curriculum
14. Previous experience, either scholastic or occupationally, in the curriculum in which the student was enrolled
15. First semester grade point average at Northampton County Area Community College.

Data Treatment

After the variables were compiled, coded, and keypunched, for each student, the data were analyzed using the University of Florida's IBM 360 computer. The computer program BMDO3R (10) was used to perform a multiple regression analysis for each curriculum. The output of this program included coefficients of determination, multiple correlation coefficients, variance of estimates, standard error of estimates, and F values for each model. Also computed for each model were the regression coefficients, standard error of regression coefficients, and the proportion of variance accounted for by each variable. Finally, the program produced means, standard deviations, t values, and computed the intercorrelations between each of the variables.

In order to test for the adequacy of the sample sizes the expected shrinkage in the multiple correlation coefficients were calculated using Nunnally's (50, p. 164) formula:

$$\acute{R}^2 = 1 - (1 - R^2)\left(\frac{N - 1}{N - k}\right)$$

where $\acute{R}$ = unbiased estimate of population multiple correlation,
R = multiple correlation found in sample of size N,
k = number of independent variables.

Summary

This study utilized data collected from a community college's admissions and records offices for a sample size of 50 dental hygiene and 94 nursing students for the purpose of developing grade point average prediction models. The computer program BMDO3R generated data which were used to determine the prediction models for each curriculum.

CHAPTER 4

MODEL DEVELOPMENT

Introduction

This portion of the research report will discuss the results of the analysis of data which was performed by the University of Florida's IBM 360 computer using the University of California Computer program BMDO3R, a multiple linear regression program.

This investigation was undertaken to develop a set of equations which could be used to predict first semester grade point averages of students in dental hygiene and nursing programs. Twelve predictor variables and one criterion variable were studied. The sample studied consisted of 50 women enrolled in the dental hygiene curriculum and a total of 94 students, including 85 women and 9 men, enrolled in the nursing curriculum. This sample included students enrolled in a community college between 1969 and 1971.

A correlation matrix was developed for each program in order to show the relationship of the individual predictors with each other as well as with the criterion variable. The individual correlation coefficients provide a means of comparing the relative effectiveness of each of the predictors with the criterion variable.

Two prediction models were developed for each program by using the multiple regression technique. Each model has the form:

$$\hat{Y} = \alpha + B_1X_1 = \ldots B_{12}X_{12}$$

where $\hat{Y}$ = the predicted grade point average for each student,
α = the intercept or constant, and
B_n= the least squares regression coefficient for variable X_n.

Dental Hygiene

The sample for the dental hygiene curriculum included 50 students. The study investigated 12 predictor variables and 1 criterion variable. The following notation was used to indicate each variable:

X_1 = High School Percentile Rank

X_2 = ACT English Score

X_3 = ACT Mathematics Score

X_4 = ACT Social Science Score

X_5 = ACT Natural Science Score

X_6 = ACT Composite Score

X_7 = High School English Grade Point Average

X_8 = High School Mathematics Grade Point Average

X_9 = High School Social Science Grade Point Average

X_{10} = High School Natural Science Grade Point Average

X_{11} = Age

X_{12} = Previous Experience

X_{13} = First Semester College Grade Point Average.

The means and standard deviations for the variables included in the dental hygiene sample are noted in Table I.

The correlation coefficients between the variables for the dental hygiene sample are indicated in Table II. An investigation of the relationships between individual predictors and the college grade point average reveals that only small correlations existed between the criterion variable (first semester grade point average) and each of the following predictor variables: ACT Composite score (.00), prior experience (.03), ACT English score (.10), ACT Natural Science score (-.12), ACT Social Science score (-.14), and ACT Mathematics score (.17). The highest correlations with the criterion variable were high school mathematics average (.50) and age (.43).

The least square regression weights (Table III) for the dental hygiene predictor variables were utilized to develop the following prediction equation:

Dental Hygiene Model I

$$
\begin{aligned}
Y_{11} = -.651 - .002X_1 - .036X_2 + .040X_3 - .032X - \\
.010X_5 + .043X_6 + .031X_7 + .196X_8 + \\
.115X_9 + .287X_{10} + .104X_{11} + .074X_{12}
\end{aligned}
$$

where Y_{11} = the predicted first semester grade point average for dental hygiene applicants, using all the predictor variables in this study.

The low correlations found between the ACT scores and the grade point averages of dental hygiene students are substantiated when the standard error of the regression

TABLE I

Means and Standard Deviations of Variables for Dental Hygiene Students

Variable		Mean	S.D.
X_1	Percentile Rank	64.72	21.38
X_2	ACT English	19.28	3.18
X_3	ACT Mathematics	17.84	5.90
X_4	ACT Social Science	18.79	5.37
X_5	ACT Natural Science	18.98	4.82
X_6	ACT Composite	18.90	3.79
X_7	High School English	2.73	.63
X_8	High School Mathematics	2.33	.72
X_9	High School Social Science	2.72	.64
X_{10}	High School Natural Science	2.41	.57
X_{11}	Age	19.42	3.33
X_{12}	Previous Experience	.26	.44
X_{13}	First Semester Grade Point Average	2.66	.55

TABLE II

Dental Hygiene Correlation Coefficient Matrix

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_1 Percentile Rank		.46	.43	.20	.23	.40	.76	.66	.57	.55	-.25	-.27	.25
X_2 ACT English			.70	.53	.48	.82	.44	.26	.50	.07	.18	-.34	.10
X_3 ACT Mathematics				.31	.42	.77	.40	.38	.49	.03	.44	-.51	.17
X_4 ACT Social Science					.63	.78	.17	.01	.38	.16	-.15	-.17	-.14
X_5 ACT Natural Science						.80	.31	.09	.36	.07	-.32	-.34	-.12
X_6 ACT Composite							.40	.23	.54	.07	-.36	-.43	.00
X_7 High School English								.68	.77	.60	-.21	-.34	.32
X_8 High School Mathematics									.48	.65	-.12	-.30	.50
X_9 High School Social Science										.45	-.29	-.52	.22
X_{10} High School Natural Science											-.03	.03	.37
X_{11} Age												.44	.43
X_{12} Previous Experience													.03
X_{13} First Semester Grade Point Average													

TABLE III

Regression Coefficients, Standard Error of Regression Coefficients, and t Values for Dental Hygiene Model I

Variable	Regression Coefficients	Standard Error of Regression Coefficients	t Value
X_1 Percentile Rank	-0.002	0.004	-0.4628
X_2 ACT English	-0.036	0.060	-0.6000
X_3 ACT Mathematics	0.040	0.054	0.7342
X_4 ACT Social Science	-0.032	0.056	-0.5653
X_5 ACT Natural Science	-0.010	0.054	-0.1768
X_6 ACT Composite	0.043	0.210	0.2049
X_7 High School English	-0.031	0.208	-0.1473
X_8 High School Mathematics	0.196	0.147	1.3306
X_9 High School Social Science	0.115	0.178	0.6454
X_{10} High School Natural Science	0.287	0.183	1.5639
X_{11} Age	0.104	0.021	4.8733*
X_{12} Previous Experience	0.074	0.182	0.4064

*Significant above the 99 percent level of confidence.

coefficients are considered. As is shown in Table III, all of the predictor variables except high school mathematics, high school natural science, and age have larger standard error of regression coefficients than the regression coefficient itself.

The data reported in Table III also reveal that t tests showed significant differences at an acceptable level for only one variable. Specifically, tests of significance between the mean scores on the predictor variables of age were found to be statistically significant above the 99 percent level of confidence.

The multiple correlation coefficient (R) of .78 shows a relatively strong relationship between the predictor and criterion variables. The calculation of the shrinkage, due to sample size, of the multiple correlation for the dental hygiene predictor model was made using Nunnally's (50, p. 164) formula. The unbiased estimate of population multiple correlation for the dental hygiene model was .70, or a reduction of .08 in the multiple correlation for the dental hygiene prediction model developed in this study.

The F value as indicated in Table IV was 4.866 and is significant above the 99 percent level with 12 and 37 degrees of freedom. The coefficient of determination (.61) indicates that 61 percent of the total variance of dental hygiene grade point averages was accounted for by this model.

TABLE IV

Analysis of Variance for Dental Hygiene Model I

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Due to Regression	12	9.073	0.756	4.866*
Deviation About Regression	37	5.750	0.155	
Total	49	14.823		

*Significant above the 99 percent level of confidence.

Table V shows the variance accounted for in dental hygiene grade point averages by each predictor variable. The variable which accounted for the largest proportion of the variance in the dental hygiene grade point average was the student's age (.279). Another variable which accounted for a large portion of the variance (.123) was the high school mathematics grade point average, while the variances accounted for by the student's high school rank and the high school English grade point average were (.060) and (.052), respectively.

The standard error of estimate, which indicates the expected distribution of predicted grade point averages for various values of the predictors, may be used to obtain an estimate of the confidence which one may place in a predicted score. Accordingly, it would be expected that actual grade point averages for two-thirds of the dental hygiene

TABLE V

Proportion of Variance Accounted for by Predictors in Dental Hygiene Model I

Variable	Proportion of Variance Accounted for
X_1 Percentile Rank	.060
X_2 ACT English	.000
X_3 ACT Mathematics	.012
X_4 ACT Social Science	.042
X_5 ACT Natural Science	.015
X_6 ACT Composite	.001
X_7 High School English	.052
X_8 High School Mathematics	.123
X_9 High School Social Science	.000
X_{10} High School Natural Science	.027
X_{11} Age	.279
X_{12} Previous Experience	.002
Total Variance Accounted for	.613

applicants would fall within ± .39 of predicted averages. The grade point averages of the remaining one-third may be expected to differ from their actual values by more than ± .39 points. For example, students with predicted grade point averages of 3.00 could be expected 68 percent of the time to receive grade point averages between 2.61 and 3.39, and 32 percent of the time to receive grade point averages of less than 2.61 or greater than 3.39.

Since only one variable, age, was significant above the 99 percent level of confidence, another multiple regression analysis was performed using as predictors the two variables (age and high school mathematics average) which accounted for the highest proportion of the variance in Dental Hygiene Model I. The least square regression weights (Table VI) were utilized to develop Dental Hygiene Model II:

$$Y_{12} = .074 + .431X_8 + .081X_{11}$$

where Y_{12} = the predicted first semester grade point average for dental hygiene students.

TABLE VI

Regression Coefficients, Standard Error of Regression Coefficients, and t Values for Dental Hygiene Model II

Variable	Regression Coefficients	Standard Error of Regression Coefficients	t Value
X_8 High School Mathematics Average	.431	.080	5.356*
X_{11} Age	.081	.017	4.717*

*Significant above the 95 percent level of confidence.

A review of Table VI reveals that t tests indicate that both of the predictor variables (high school mathematics average and age) are statistically significant above the 95 percent level of confidence.

For the Dental Hygiene Model II, the multiple correlation (R) of .70 shows a moderate relationship between the predictor variables and the first semester grade point average. The F value as indicated in Table VII was 22.726 and is statistically significant above the 95 percent level of confidence with 2 and 47 degrees of freedom. The coefficient of determination (.49) indicates that 49 percent of the total variance of dental hygiene first semester grade point averages was accounted for by the predictors in Dental Hygiene Model II.

TABLE VII

Analysis of Variance for Dental Hygiene Model II

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Due to Regression	2	7.287	3.644	22.726*
Deviation About Regression	47	7.536	0.160	
Total	49	14.823		

*Significant above the 95 percent level of confidence.

Table VIII shows the variance accounted for in dental hygiene grade point averages by each predictor variable in Dental Hygiene Model II. The variable which accounted for the largest proportion of the variance was the student's high school mathematics average (.251), while the student's age (.241) accounted for the remainder of the variance.

TABLE VIII

Proportion of Variance Accounted for by Each Predictor in Dental Hygiene Model II

Variable	Proportion of Variance Accounted for
X_8 High School Mathematics Average	.251
X_{11} Age	.241
Total Variance Accounted for	.492

The standard error of estimate (.40) indicates the expected range of a predicted grade point average for an individual student. In Dental Hygiene Model II, the predicted grade point average may vary ± .40 from the actual average in approximately two-thirds of the cases and by more than ± .40 in the other one-third of the cases.

Although age appears to be a major factor in the prediction of first semester grade point averages for dental hygiene students, upper limits most certainly must be established. A significant relationship such as is found between first semester grade point average and age in the dental hygiene models does not necessarily imply that a linear relationship exists through the entire possible range for the predictor variable. In order to determine a possible threshold beyond which this relationship does not hold, graphs of the variables were plotted against first semester grade point average. From inspection of these graphs, it appeared that the linear model for age was appropriate for the cases included in the analysis with the exception of a few cases above 27 years of age. There were an insignificant number of older students to establish the relationship above this point. Therefore, it is recommended that for the purposes of employing age as a predictor in the dental hygiene models, the age of 27 should be considered as the maximum value which is to be substituted in the equations.

Nursing

The sample for the nursing curriculum included 94 students. The study investigated 12 predictor variables and 1 criterion variable. The following notation was used to indicate each variable:

X_1 = High School Percentile Rank

X_2 = ACT English Score

X_3 = ACT Mathematics Score

X_4 = ACT Social Science Score

X_5 = ACT Natural Science Score

X_6 = ACT Composite Score

X_7 = High School English Grade Point Average

X_8 = High School Mathematics Grade Point Average

X_9 = High School Social Science Grade Point Average

X_{10} = High School Natural Science Grade Point Average

X_{11} = Age

X_{12} = Previous Experience

X_{13} = First Semester College Grade Point Average

The means and standard deviations for the variables included in the nursing sample are noted in Table IX.

The correlation coefficients between the variables for the nursing sample are indicated in Table X. An investigation of the relationships between individual predictors and the college grade point average reveals that only small correlations existed between the criterion variable (first semester grade point average) and each of the following predictor variables: ACT Mathematics score (.00), Social Science score (.12), Natural Science score (.13), Composite score (.12), and previous experience (.12). The highest correlations with the criterion variable were all associated with the student's high school record. The highest correlation was the high school rank (.49), followed by the high school grade point averages in mathematics (.42), natural science (.42), English (.41), and social science (.41).

The least square regression weights (Table XI) for the nursing predictor variables were utilized to develop the following prediction equation:

Nursing Model I

$$Y_{21} = 1.064 + .009X_1 + .097X_2 + .094X_3 + .080X_4 + .104X_5 - .372X_6 + .000X_7 + .090X_8 + .072X_9 -$$

$$.005X_{10} + .035X_{11} + .154X_{12}$$

where Y_{21} = the predicted first semester grade point average for nursing applicants using all of the predictor variables in this study.

The data reported in Table XI reveal that t tests showed a significant difference at an acceptable level for only one variable. Specifically, tests of significance between the mean scores on the predictor variable of age were found to be statistically significant above the 95 percent level of confidence.

The multiple correlation coefficient (R) of .61 shows a moderate relationship between the predictor and criterion variables. The calculation of the shrinkage, due to sample size, of the multiple correlation for the nursing predictor model was made using Nunnally's (50, p. 164) formula. The unbiased estimate of population multiple correlation for the nursing model was .54, or a reduction of .07 in the multiple correlation for the nursing predictor model developed in this study.

The F value as indicated in Table XII was 4.033 and is significant above the 99 percent level with 12 and 81 degrees of freedom. The coefficient of determination (.37) indicates that 37 percent of the total variance of nursing grade point averages was accounted for by this model.

Table XIII shows the variance accounted for in nursing grade point averages by each predictor variable. The variable which accounted for the largest proportion of the variance in the nursing grade point average was the student's

TABLE IX

Means and Standard Deviations of Variables for Nursing Students

Variable	Mean	S.D.
X_1 Percentile Rank	52.79	25.56
X_2 ACT English	18.82	4.02
X_3 ACT Mathematics	15.82	5.77
X_4 ACT Social Science	19.12	5.81
X_5 ACT Natural Science	19.77	5.42
X_6 ACT Composite	18.51	4.12
X_7 High School English	2.49	.73
X_8 High School Mathematics	2.07	.85
X_9 High School Social Science	2.48	.78
X_{10} High School Natural Science	2.27	.65
X_{11} Age	22.29	5.62
X_{12} Previous Experience	0.64	.48
X_{13} First Semester Grade Point Average	2.78	.70

TABLE X

Nursing Correlation Coefficient Matrix

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_1 Percentile Rank		.44	.23	.29	.27	.38	.83	.76	.80	.75	.08	.06	.49
X_2 ACT English			.41	.54	.52	.75	.48	.32	.40	.29	.03	.11	.19
X_3 ACT Mathematics				.35	.38	.71	.25	.32	.21	.15	-.37	-.12	.00
X_4 ACT Social Science					.69	.83	.34	.20	.35	.17	.02	.08	.12
X_5 ACT Natural Science						.82	.31	.20	.32	.17	.09	.08	.13
X_6 ACT Composite							.43	.33	.39	.24	-.16	-.12	.12
X_7 High School English								.73	.83	.68	.00	-.11	.41
X_8 High School Mathematics									.63	.70	.12	-.13	.42
X_9 High School Social Science										.67	.03	-.11	.41
X_{10} High School Natural Science											.15	.05	.42
X_{11} Age												.23	.33
X_{12} Previous Experience													.12
X_{13} First Semester Grade Point Average													

TABLE XI

Regression Coefficients, Standard Error of Regression Coefficients, and t Values for Nursing Model I

Variable	Regression Coefficients	Standard Error of Regression Coefficients	t Value
X_1 Percentile Rank	0.009	0.005	1.6963
X_2 ACT English	0.097	0.056	1.7020
X_3 ACT Mathematics	0.094	0.055	1.7005
X_4 ACT Social Science	0.080	0.053	1.5081
X_5 ACT Natural Science	0.104	0.053	1.9512
X_6 ACT Composite	-0.372	0.206	-1.8036
X_7 High School English	0.000	0.189	0.0018
X_8 High School Mathematics	0.090	0.132	0.6801
X_9 High School Social Science	0.071	0.157	0.4530
X_{10} High School Natural Science	-0.005	0.154	-0.0337
X_{11} Age	0.035	0.013	2.6487*
X_{12} Previous Experience	0.154	0.135	1.1367

*Significant above the 95 percent level of confidence.

TABLE XII

Analysis of Variance for Nursing Model I

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Due to Regression	12	16.946	1.412	4.033*
Deviation About Regression	81	28.364	0.350	
Total	93	45.310		

*Significant above the 99 percent level of confidence.

TABLE XIII

Proportion of Variance Accounted for by Predictors in Nursing Model I

Variable		Proportion of Variance Accounted for
X_1	Percentile Rank	.244
X_2	ACT English	.001
X_3	ACT Mathematics	.014
X_4	ACT Social Science	.000
X_5	ACT Natural Science	.002
X_6	ACT Composite	.017
X_7	High School English	.000
X_8	High School Mathematics	.015
X_9	High School Social Science	.000
X_{10}	High School Natural Science	.001
X_{11}	Age	.070
X_{12}	Previous Experience	.009
	Total Variance Accounted for	.373

high school percentile rank (.244). The only other variable which appeared to account for a sizeable portion of the variance was the student's age.

The standard error of estimate, which indicates the expected distribution of predicted grade point averages for various values of the predictors may be used to obtain an estimate of the confidence which one may place in a predicted score. Accordingly, it would be expected that actual grade point averages for two-thirds of the nursing applicants would fall within ± .59 of predicted averages. The grade point averages of the remaining one-third may be expected to differ from their actual values by more than ± .59 points. For example, students with predicted grade point averages of 3.00 could be expected 68 percent of the time to receive grade point averages between 2.41 and 3.59, and 32 percent of the time to receive grade point averages of less than 2.41 or greater than 3.59.

Since only one variable, age, was significant above the 95 percent level of confidence, another multiple regression analysis was performed using as predictors the two variables (high school percentile rank and age) which accounted for the highest proportion of the variance in Nursing Model I. The least square regression weights (Table XIV) were utilized to develop Nursing Model II:

Nursing Model II

$$Y_{22} = 1.296 + .013X_1 + .036X_{11}$$

where Y_{22} = the predicted first semester grade point average for nursing students.

TABLE XIV

Regression Coefficients, Standard Error of Regression Coefficients, and t Values for Nursing Model II

Variable	Regression Coefficients	Standard Error of Regression Coefficients	t Value
X_1 High School Percentile Rank	.013	.002	5.453*
X_{11} Age	.036	.010	3.390*

*Significant above the 95 percent level of confidence.

A review of Table XIV reveals that t tests indicate that both of the predictor variables (high school percentile rank and age) are significant above the 95 percent level of confidence.

For the Nursing Model II, the multiple correlation (R) of .57 shows a moderate relationship between the predictor variables and the first semester grade point average. The F value as indicated in Table XV was 22.289 and is statistically significant above the 99 percent level of confidence with 2 and 91 degrees of freedom. The coefficient of determination (.33) indicates that 33 percent of the total variance of nursing first semester grade point averages was accounted for by the predictors in Nursing Model II.

Table XVI shows the variance accounted for in the nursing grade point averages by each predictor variable in Nursing Model II. The variable which accounted for the largest proportion of the variance was the student's high school percentile rank (.244), while the student's age (.085) accounted for the remainder of the variance.

TABLE XV

Analysis of Variance for Nursing Model II

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F Value
Due to Regression	2	14.898	7.449	22.289*
Deviation About Regression	91	30.412	0.334	
Total	93	45.310		

*Significant above the 95 percent level of confidence.

TABLE XVI

Proportion of Variance Accounted for by Each Predictor in Nursing Model II

Variable	Proportion of Variance Accounted for
X_1 High School Percentile Rank	.244
X_{11} Age	.085
Total Variance Accounted for	.329

The standard error of estimate (.58) indicates the expected range of a predicted grade point average for an individual student. In Nursing Model II, the predicted grade point average may vary within ± .58 of the actual average in approximately two-thirds of the cases and by more than ± .58 in the remaining one-third of the cases.

Although age appears to be a factor in the prediction of grades for nursing applicants, upper limits most certainly must be established. A significant relationship such as that found between first semester grade point average and age in nursing models does not necessarily imply that a linear relationship exists through the entire possible range for the predictor variable. In order to determine a possible threshold beyond which this relationship does not hold, graphs of the variables were plotted against first semester grade point average. From inspection of these graphs it appeared that the linear model for age was appropriate for the cases included in the analysis with the exception of a few cases above 30 years of age. There were an insufficient number of older students to establish the relationship above this point. Therefore, it is recommended that for the purposes of employing age as a predictor in the nursing models, the age of 30 should be considered as the maximum value which is to be substituted in the equations.

Summary

This chapter presented the correlations between the criterion variable, first semester grade point average, and 12 predictor variables which were obtained in this study of dental hygiene and nursing students. Least square regression weights were utilized to develop predictive models for the dental hygiene and nursing programs.

It was shown that ACT scores had a relatively insignificant correlation with the first semester grade point averages for both the dental hygiene and nursing students. Therefore, one might question the necessity of requiring the test for admission to these programs. The best individual predictors of first semester grade point averages appear to be the applicant's age at the time he enrolls and the applicant's high school performance as indicated by his high school rank or his grade point average in individual subjects. With respect to the value of the applicant's age as a predictor, it should be noted that although there appeared to be moderate correlations between the grade point average and age, there are most assuredly some limits within which the relationship will be effective.

The fifth chapter consists of a discussion of the utilization of the prediction models as aids in the admissions process as well as conclusions derived from this investigation and recommendations for further study.

CHAPTER 5

USE OF THE MODELS, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This study was planned to investigate how well presently available academic and selected biographical data which were routinely obtained for each applicant can be used to predict first semester grade point averages for dental hygiene and nursing program enrollees. The investigation of the relationship between the predictor variables and the criterion variable of first semester grade point average resulted in the development of a prediction model for each program which can be used by admissions personnel as an aid in the evaluation of credentials of applicants to dental hygiene and nursing programs.

Use of the Models

The models which were developed in this study are as follows:

Dental Hygiene Model I

$$Y_{11} = -.651 - .002X_1 - .036X_2 + .040X_3 - .032X_4 - .010X_5 + .043X_6 + .031X_7 + .196X_8 + .115X_9 + .287X_{10} + .104X_{11} + .074X_{12}.$$

Dental Hygiene Model II

$$Y_{12} = .074 + .431X_8 + .081X_{11}$$

where Y_{11} and Y_{12} = the predicted first semester grade point average for dental hygiene applicants.

Nursing Model I

$$Y_{21} = 1.064 + .009X_1 + 097X_2 + .094X_3 + .080X_4 + .104X_5 - .372X_6 + .000X_7 + .090X_8 + .072X_9 - .005X_{10} + .035X_{11} + .154X_{12}.$$

Nursing Model II

$$Y_{22} = 1.296 + .013X_1 + .036X_{11}$$

where Y_{21} and Y_{22} = the predicted first semester grade point average for nursing applicants.

There are several relevant statistical factors which should be taken into consideration in the determination of which models are most appropriate for the prediction of first semester grade point averages for dental hygiene and nursing applicants. In comparing the two dental hygiene models, only 1 of the 12 variables was statistically significant in Dental Hygiene Model I, while both of the predictor variables were statistically significant in Dental Hygiene Model II. In addition, although there is a difference in multiple correlations of .08 between Dental Hygiene Model I (R = .78) and Dental Hygiene Model II (R = .70) the standard error of estimate only differs by .01 for the two models. Thus, it would appear that Dental Hygiene Model II is an adequate predictor and therefore the expenditure of the extra time and effort to calculate the predicted first semester grade point average is hardly justified.

In comparing the two nursing models, only 1 of the 12 predictor variables was stastically significant in Nursing Model I, while both of the predictor variables were statistically significant in Nursing Model II. In addition, although there is a difference in multiple correlations of .04 between Nursing Model I (R = .61) and Nursing Model II (R = .57), the standard error of estimate only differs by .01 for the two models. Thus, it would appear that Nursing Model II is an adequate predictor and therefore the expenditure of the extra time and effort to calculate the predicted first semester grade point average is hardly justified.

The use of the prediction models centers around the problem of selection, from a large number of applicants, of those individuals who are most likely to be successful in dental hygiene and nursing programs in which there is limited space. The admission procedure of the college can be developed around the utilization of the prediction models produced by this study. The predictor variables can be collected for each applicant, then coded and the data entered into the computer file. At selected periods of time, the computer can list in separate reports all applicants who have applied for the two programs. The applicants' names can be listed in hierarchical fashion based upon the predicted grade point average and can, therefore, be categorized into qualified, marginally qualified, and not qualified groups. These categories should be defined by each college, utilizing the predictive equations, and can be based upon factors such as the number of applicants to the program and the size of the prospective freshman class. Those in the qualified group can be sent offers of admission immediately, those in the marginally qualified group can be asked to arrange an interview with an admissions counselor and program chairman to discuss entrance into the program, while those in the not qualified category will be asked to meet with the admissions counselor to discuss possible alternate programs. Final admissions decisions in the latter two categories will be based upon the recommendations of the admissions counselor and/or the program chairman.

It is recognized that the computer is merely a tool, but it is a powerful tool which can be used to manipulate data with speed and accuracy. These data embrace a much greater range of information than has been feasible to collect and utilize in the past. Data which were not practicable to obtain by hand counts can be more readily available for use by the admissions staff in discussions with students, parents, and faculty. If the identification of students who may experience academic difficulty can be done mathematically, using the models developed in this study, it should be possible for the admissions staff to provide additional time and support to those students who probably need increased counseling and guidance. An example of this need for special attention for students with potential academic problems is specified in one of the conclusions of a study by Berger and Sutker (4). They assert that since failure in the early portion of a student's college career seems to parallel later performance, it is extremely important to begin an early counseling program for students who may experience academic difficulty.

Conclusions

The following conclusions can be drawn from this study:

1. The contrast in the correlations between individual predictors and the first semester grade point averages as well as the differences in the proportion of variance in grade point averages accounted for by the predictor variables for the dental hygiene and nursing applicants strongly points to the need for a prediction model for each program rather than for the totality of college programs.
2. The individual predictors in this study were found to predict only a portion of the criterion variable of first semester grade point average. In neither of the curricula could a convincing case be constructed for recommending only one predictor to the exclusion of all others.
3. The models which appeared to predict first semester grade point averages most efficiently were:

$Y_{12} = .074 + .431X_8 + .081X_{11}$

where X_8 = high school mathematics grade point average

X_{11} = age, and

Y_{12} = the predicted first semester grade point average for dental hygiene applicants.

$Y_{22} = 1.296 + .013X_1 + .036X_{11}$

where X_1 = high school percentile rank,

X_{11} = age, and

Y_{22} = the predicted first semester grade point average for nursing applicants.

The combination of the variables in the multiple regression equations have acceptable multiple correlations when predicting the first semester grade point averages for applicants to both dental hygiene and nursing programs.

4. Age was a major factor in the prediction of first semester grade point averages for both dental hygiene and nursing applicants; however, it was necessary to define upper age limits in order that this factor be prevented from exaggerating its role as a predictor for older students. From data acquired from the sample, it was concluded that, for the purpose of substitution in the models, the ages of 27 and 30 be considered as maximum ages for applicants in the dental hygiene and nursing programs, respectively.
5. The first semester grade point averages were more predictable for dental hygiene applicants than were the first semester grade point averages for nursing applicants.

6. An intellectual variable, high school mathematics grade point average,was the best single predictor of dental hygiene first semester grade point averages in that it accounted for 25.1 percent of the variance in the model.
7. An intellectual variable, high school percentile rank, was the best single predictor of nursing first semester grade point averages in that it accounted for 24.4 percent of the variance in the model.
8. The American College Testing Program scores did not relate significantly to first semester grade point averages for the dental hygiene or nursing program.
9. This study suggests that there might be other factors for admissions officers and counselors to investigate when considering which students to accept for admission into programs with limited enrollments. Motivational and attitudinal factors which may be determined in either a formal setting such as testing or a more casual atmosphere such as an interview should be taken into account when considering students for admission.
10. Since the multiple regression equations have acceptable multiple correlations, it is suggested that these prediction models be utilized by admissions personnel as an aid in the selection and counseling of applicants who may be admitted into the dental hygiene and nursing programs.
11. These models may also serve as counseling devices in the counseling of those applicants who have been refused

admission to the dental hygiene and nursing programs. If students can be given reasons why they are not being recommended for acceptance to the program of their first choice, then they might be able to accept the decision and begin the process of selecting another occupational goal.

Recommendations

The following recommendations are made as a consequence of the review of the literature and the results of this study.

1. This study was only concerned with the development of prediction equations. However, it is recognized that an additional study of dental hygiene and nursing students should be made to validate and refine the equations produced by this study prior to their use in any other institution.
2. A replication of this study should be performed using a sample determined from several different community colleges. The results of a study such as the one recommended could be compared with the results of this study to determine if there are significant differences between students' grade point averages at individual colleges.
3. Research studies should be performed using a combination of other variables and those variables identified in

this study as good predictors of the first semester grade point average for dental hygiene and nursing applicants. Since the study of grade point average predictability for nursing and dental hygiene students in the community college has been largely ignored, research on both a multicollege scale as well as for individual colleges is still needed to provide additional data concerning those applicants who have reasonable chances of successfully completing their program of study.

4. As a possible research project which might further extend the work of this research, the writer would suggest that a prediction study might be made of dental hygiene and nursing applicants which would include nonacademic factors. If there exist nonacademic factors which assist in the predictability of success in college, then it would be possible to identify the students, who after completing some remedial work to remedy academic deficiencies, would be able to complete the dental hygiene or nursing program. A study of this sort would greatly enhance the possibility of acceptance of minority group students and "late bloomers" who may not perform well on the traditional academic measures, but who may have the ability, interest, and desire to become employed in one of these fields.
5. This research can be considered as a pilot study for the development of other projects involving the determination

of variables which can be useful in predicting grade point averages for technical programs, other than dental hygiene or nursing, in community colleges.

Summary

As one considers the rationale for the development of this study, an obvious concern arises for those applicants who are not accepted into the program of their first choice. Admissions officers and counselors should do more than choose from a large number of applicants those who will be privileged to begin the study of dental hygiene or nursing. The admissions staff must guide the applicant into programs where the chance of academic success is more probable and where the individual can reach a level of success commensurate with his abilities, skills, and interests. Therefore, community colleges must develop within the admissions organization a system of personal and vocational guidance and counseling for those students who cannot be accepted into the program of the first choice.

It is incumbent upon each community college admissions officer, in this era of extreme budgetary concern in the field of education, to make the best possible selection of applicants to programs. For every student who does not succeed in, or who withdraws from, a program there may be a number of applicants who could have succeeded had they been given a chance. Therefore, the wasting of economic, physical, and human resources of the college as well as the individual's time and resources must be a concern of every member of the admissions staff. The prediction equation developed in this study can provide admissions officers with assistance in processing applications of the students who have applied for programs which have limited enrollment.

APPENDIX

CODING SCHEME

Column	
1 - 3	Number
4	Curriculum
5 - 6	High School Percentile Rank
7 - 8	ACT English Score
9 - 10	ACT Mathematics Score
11 - 12	ACT Social Science Score
13 - 14	ACT Natural Science Score
15 - 16	ACT Composite Score
17 - 19	High School English Grade Point Average
20 - 22	High School Mathematics Grade Point Average
23 - 25	High School Social Science Grade Point Average
26 - 28	High School Natural Science Grade Point Average
29 - 30	Age, in years
31	Previous Experience--(Y) Yes or (N) No
32 - 34	First Semester College Grade Point Average

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BIOGRAPHICAL SKETCH

Kenneth Charles Kochey was born September 21, 1937, at Cheltenham, Pennsylvania. He graduated from Cheltenham High School in 1955 and then enrolled at Millersville State College, where he received the degree of Bachelor of Science in Education in 1959. Following graduation he taught junior high school mathematics until 1962, when he received a National Science Foundation Summer Institute grant to attend Portland State College. In the fall of 1962, Mr. Kochey enrolled at Louisiana State University in a National Science Foundation Academic Year Institute, and received the degree of Master of Arts with a major in mathematics in August, 1963. After teaching mathematics at Pensacola Junior College for one year, he was awarded a Kellogg Fellowship and enrolled at the University of Florida in September, 1964. Upon the completion of one year at the University of Florida, he was awarded a Washington Internship in Education Fellowship at the American Association of Junior Colleges, which he held until August, 1966. He then returned to the University of Florida and received the degree of Specialist in Education in June, 1967. In August, 1967, he accepted a position as Assistant to the President at Northampton County Area Community College, where he is currently employed as Dean of Student Services.

Kenneth Charles Kochey is married to the former Sharon Kay Cox. He is a life member of the National Education Association and the American Association of Higher Education. He is also a member of the Middle States Association of Collegiate Registrars and Officers of Admission, and the American Association of Collegiate Registrars and Admissions Officers.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

James L. Wattenbarger

James L. Wattenbarger, Chairman
Professor of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

John M. Nickens

John M. Nickens, Co-Chairman
Assistant Professor of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

Willis A. LaVire

Willis A. LaVire
Associate Professor of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

Norman G. Keig

Norman G. Keig
Associate Professor of Economics

This dissertation was submitted to the Dean of the College of Education and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Education.

August, 1972

B. S. Sharp by M C Baker

Dean, College of Education

Dean, Graduate School